State of California
Resources Agency
Department of Water Resources
Southern District
Resources Assessment Branch
Groundwater Section

Technical Information Record SD-07-03

A Summary of the Drilling and Completion of the Borrego Water District Monitoring Well MW-4 with Geologic and Geophysical Observations and Initial Interpretations

May 2007

Mark Stuart — Chief, Southern District

Prepared under the direction of

Bob Pierotti — Chief, Resources Assessment Branch

By

Doug Ellis — Engineering Geologist

Timothy M. Ross — Engineering Geologist

This TIR is primarily a working paper and is subject to revision or replacement

Introduction

Monitoring well MW-4 was completed as part of a project partially funded by a Local Groundwater Management Assistance Act[1] (AB303) grant awarded to the Borrego Water District to help develop a monitoring well network in the Borrego Valley groundwater basin. The network is being established to increase the district's ability to monitor and record the groundwater levels and quality in the basin. The enhanced data collection will help the Borrego Water District optimize its groundwater management plan to mitigate a significant overdraft condition in the basin. Other monitoring wells in the network, MW-1 and MW-3, were completed in 2004, the latter being documented in Ross, 2005. Monitoring wells MW-4 and MW-5 were completed in 2006 and are documented here and in Ellis and Ross, 2007, respectively. In addition to these recently drilled monitoring wells, several existing public and private supply wells and private irrigation wells, both active and abandoned, have been included as part of the network. An existing network of observation wells owned by San Diego County and monitored by the Borrego Water District provides additional groundwater level and quality data.

MW-4 is a single completion well located inside the southern perimeter fence near the east end of the runway at the Borrego Valley Airport on Palm Canyon Drive (Figure 1). The airport site for MW-4 was selected to provide groundwater level and quality data representative of the immediate area and to test the aquifer specifically for its suitability to supply a municipal water well. Geologic and geophysical data obtained at this site also provides a means to delineate the thicknesses and identities of underlying formations and examine their relation to the regional aquifer system.

The site surface is mantled in aeolian dune sand with a moderate brush overgrowth. The drill location was leveled, and a working pad was built up with the sand to accommodate the drill rig, auxiliary vehicles, and other equipment. The drilling was completed by SoCal Pump and Well Drilling, Inc. of Riverside, California using the direct rotary technique with a bentonite-based drilling mud. Steel mill-tooth tricone bits were

[1] California Water Code Section 10795 et seq.

used for drilling the borehole, and a Boart Longyear diamond coring bit with a 10-foot core recovery barrel was used for coring of selected sections.

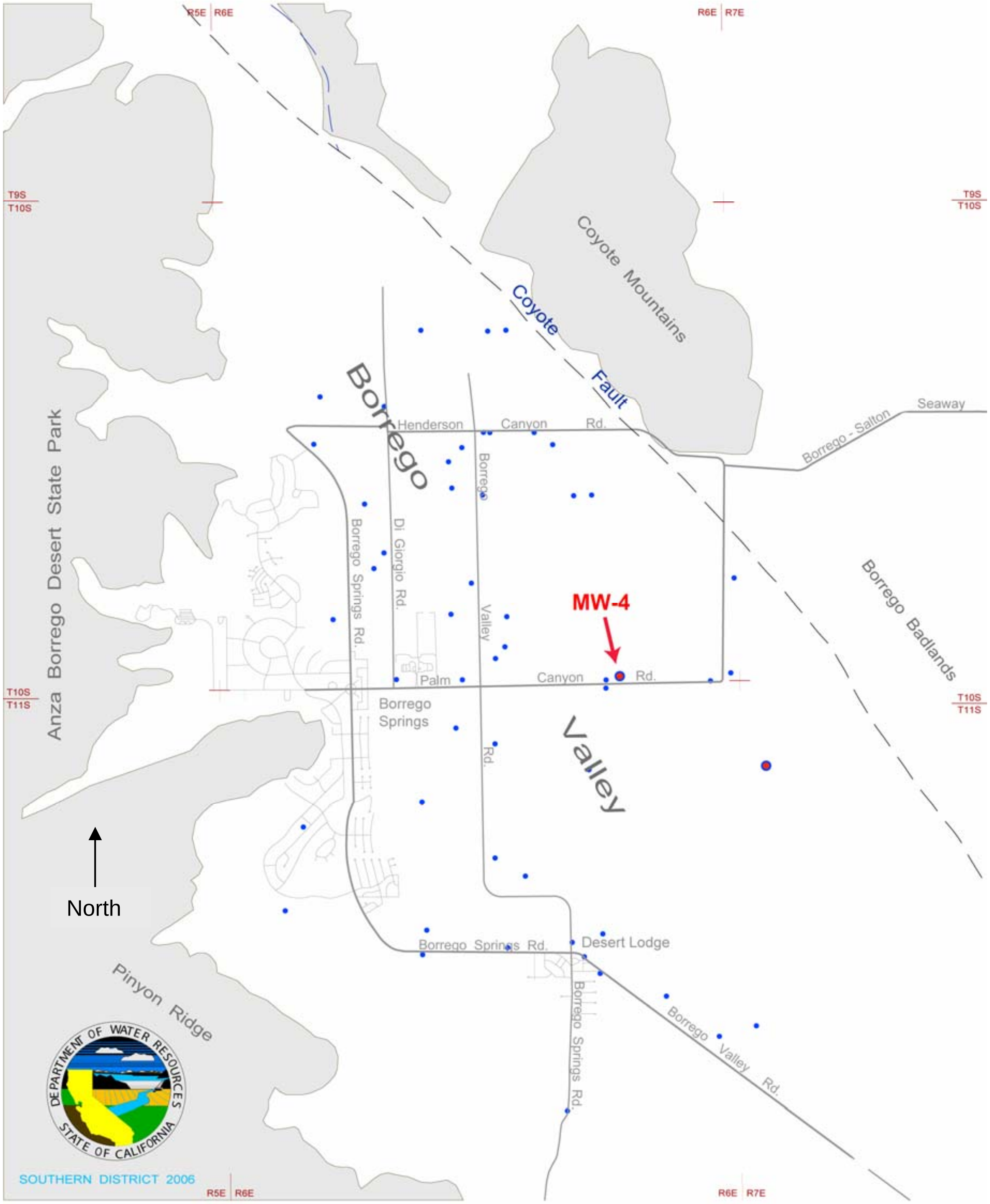


Figure 1 - Location of MW-4

During the drilling, cutting samples were collected from the returning mud at the conductor casing and, occasionally, at the shaker table as a supplement. Samples were collected using a steel-screen strainer and washed in water to remove residual drilling mud for classification and storage. Recovered core samples were cleaned, photographed, and described. The core samples are stored at the Borrego Water District office in Borrego Springs.

Well boring and completion summary

Drilling at the airport site for MW-4 commenced on July 6, 2006, at 1700 and concluded at approximately 1200 on July 26, 2006. The uppermost part of the borehole was drilled to 24 feet below land surface (bls) using a 17-inch steel mill-tooth tricone bit, reamed, and completed with a 24-foot length of 16-inch diameter steel conductor casing set without external grout. A sample of the surface aeolian sand was collected adjacent to the borehole to serve as a reference for identifying contamination in cutting samples. Samples were collected from mud returns at the borehole from depths of 10 and 20 feet bls. These first two samples were examined and found to contain a significant surface sand fraction, which likely was caused by caving or similar contamination in the absence of the conductor casing. Samples obtained at 30 feet bls, after the conductor was set and the borehole was cleared, appeared more representative of the formation encountered. Drilling continued to the total depth of the borehole (927 feet bls) using a 9-inch steel mill-tooth tricone bit. Selected core sampling intervals were drilled with the coring bit and reamed using the 9-inch tricone bit.

Sampling intervals were gauged to occur at 10-foot increments by estimating the depth from the top swivel position on the drill rig's derrick. This estimate did not account for the progressive delay or "bottoms up" time in sample collection as the borehole deepened. Initial delays were negligible and the samples collected were considered true representations of the lithology at the estimated depths. The delay at 650 feet bls, however, was measured at approximately 15 minutes, which corresponds to an offset of approximately 10 to 20 feet between the estimated depth and the sample depth of the recovered sample at the deeper intervals. This offset is taken into consideration when comparing the lithologic log with the down-hole geophysical log results.

Coring was attempted at four 10-foot intervals using a Boart Longyear coring bit and 10-foot core barrel. The first attempt was at 105 to 115 feet bls, however, no sample was recovered, presumably because of insufficient consolidation in the formation. Partial core samples were recovered from 847 to 857 feet bls (6-foot length), 867 to 877 feet bls (0.7-foot length), and 887 to 897 feet bls (0.46-foot length with loose cobbles).

A geophysical survey of the entire 927-foot deep borehole was completed by Pacific Surveys on July 27, 2007. The survey included measurements of the spontaneous potential (SP), natural gamma-ray emission, resistivity (long and short normal, single point, laterolog), sonic velocity, variable density, and borehole dimension using an x-y caliper. The data from the surveys are included as Appendix 1.

After the survey was completed, the borehole was grouted with bentonite from the bottom (927 feet bls) to 395 feet bls. The well was completed in the remaining open borehole to 390 feet bls. The completion consists of the 16-inch diameter conductor to 24 feet bls, a 6-inch diameter casing from the ground surface to 85 feet bls, and 6-inch diameter screens from 85 to 390 feet bls. Final surface completion was made flush with a recessed vault. The static depth to water in the completed well on August 4, 2006, was 94 feet bls.

Step drawdown and constant rate pumping tests were conducted on the completed well by Borrego Water District personnel. Results from these tests indicate that the well can sustain a 250-gallon per minute (GPM) yield under the present groundwater and well conditions. Water samples were drawn by Borrego Water District personnel and sent to E.S. Babcock & Sons laboratories for analysis. The major ion analysis results show that the water is a sodium sulfate type with a total dissolved solid (TDS) concentration of 720 milligrams per liter (mg/l). Saturation indices were calculated from the water quality analysis results using the U.S. Geological Survey PHREEQC geochemical modeling software (Parkhurst and Appelo, 1999). The sample was found to be saturated with respect to calcium carbonate, consistent with the light cement coating found on some sediment grains in the lithologic samples. Table 1 shows the major ion chemistry and saturation indices.

Table 1 – Water Quality Analysis and Saturation Indices for MW-4, January 8, 2007

Water Quality Analysis										
Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3	F	TDS	pH
78.0	15.0	130.0	9.4	110.0	330.0	66.0	2.4	0.5	720.0	7.8
Concentrations in mg/l										
Saturation Indices										
Calcite ($CaCO_3$)					Gypsum ($CaSO_4 \cdot 2H_2O$)					
0.27					-0.69					

Borehole description

The overall geology of the units encountered during the drilling ranges from coarse-grained sand and gravel to clay sedimentary deposits consistent with the alluvial, lacustrine, and deltaic deposits described regionally (e.g., Moyle, 1982; Cassiliano, 2002). Thin interbedding of sandy to clayey sediments are found to varying degrees throughout the borehole depth as indicated by the typically erratic trace of the long normal resistivity measurements interpreted in many places as reversals. The thin interbedding is estimated to occur on a scale of 5 or less feet and overprints a broader cyclic variation between sandy and clayey layers that occurs on a scale of tens of feet. The thinner interbedding is not continuously resolved in the lithologic log, presumably because of vertical mixing in the returning mud stream and the relatively fast drilling rate.

Generally, an overall decrease in the porosity with increasing depth is suggested by a steady increase in the sonic velocity as represented by a decrease in the return time (delta T) values. This overall decrease in porosity can be generally attributed to increasing sediment compaction and limited induration with increasing depth, although core samples from more than 800 feet bls suggest that consolidation and induration has not occurred to a significant degree. Variations in sonic velocity within the overall increasing trend are noted to coincide with lithologic changes in the strata from clay- to sand-dominated layers.

Sand-dominated layers are prevalent from approximately 140 to 330 feet bls, 480 to 780 feet bls, and more than 820 feet bls as interpreted from the geophysical logs. These interpretations generally agree with descriptions of poorly-graded sand (SP) and clayey sand (SC) recorded in the lithologic log. Some portions of these intervals, however, are generally described as clay dominated (CL), though the detailed descriptions in the lithologic log include a significant sand component.

The sand-dominated layers are typified by relatively low but varied gamma emission. An exception is found from approximately 240 to 285 feet bls where a spike in gamma emission occurs along with a number of peripheral increases in gamma emission. The spike in gamma emission may be associated with an unconformity. Clay-dominated layers are typified by a relatively high and varied gamma emission. A second possible unconformity, also represented by a spike in gamma emission, is located at approximately 400 feet bls within clay-dominated layers.

Short and long normal resistivity traces generally coincide in sand-dominant layers, but separate in a number of intervals with the long normal resistivity values decreasing relative to the short normal resistivity values. These separations are most notable from 300 to 340 feet bls and 820 to 885 feet bls. The separation suggests that the formation water has a relatively high TDS concentration. The separation is more pronounced at depths greater than 820 feet bls, which suggests that the TDS concentration of the formation water increases with greater depth representing either vertical isolation between aquifers or simple stratification within a single common aquifer.

Large fluctuations affecting both long and short normal resistivity traces occur throughout the depth of the borehole. These fluctuations often coincide with variations in the borehole diameter as recorded by the caliper log and are thus considered exaggerated relative to the true resistivity measures of the formations and mud-filled borehole.

Separations between long and short normal resistivity traces, where the short normal resistivity values decrease relative to the long normal resistivity values, coincide with borehole diameter increases in clay-dominated layers. The relative decrease in short normal resistivity values is attributed to an increase in the influence of the low resistivity drilling mud. Infiltration of drilling mud into the borehole wall is also a possible contributor to the observed separation, though the occurrence of this in clay-dominated layers is likely minimal.

Core sampling

Core sampling was completed at four depth intervals. A sample was attempted from 105 to 115 feet bls with no recovery. The interval was anticipated to coincide with the water table; however, an apparent lack of consolidation of the formation prevented recovery of any sample. Core recovery was also attempted between 847 and 857 feet bls, 867 and 877 feet bls, and 887 and 897 feet bls.

Between 847 and 857 feet bls, a 6.4-foot core sample was recovered in three pieces: a 6-foot segment, a 0.25-foot segment, and a 0.15-foot segment. The core composition is uniform throughout the sample lengths of all three segments. The grain sizes are dominantly fine sand and silt (<1 mm), with lesser coarse sand and fine gravel (up to 5 mm). The sample matrix is dominantly grain supported with some clay present in the interstices. No cementation is noted within the matrix (negative HCl reaction). Coarse sand and gravel are primarily colorless to milky quartz in angular- to subangular-grains. Coarse gravel (20 to 30 mm) is present in isolated occurrences.

Between 867 and 877 feet bls, a 0.7-foot core sample was recovered. The composition is identical to the core sample collected between 847 and 857 feet bls. The lack of recovery of more core material from this interval suggests that the formation is not well consolidated at this depth.

Between 887 and 897 feet bls, a final 0.46-foot core sample was recovered. The core sample also has an identical composition to the core samples noted above. The core sample was retained in the base of the barrel. Also retained in the barrel on top of the core sample were several coarse pebble- and cobble-sized rock fragments lying loose. The rock fragments are gneissic, plutonic, and sandstone pebbles and small cobbles that are well rounded and, in the case of the larger pieces, cut in a radius by the coring bit suggesting that they were part of a larger boulder in place. Also included are several dark-grey, fossiliferous claystone clasts that are rounded and slightly weathered.

Water-bearing zones

Based on the lithologic log and the geophysical data, three apparently distinct water-bearing zones are identified. The upper zone is between the water table at 94 feet bls and approximately 350 feet bls. The middle zone is between 430 and 780 feet bls. The lower zone extends from approximately 820 feet bls to, at least, the bottom of the borehole at 927 feet bls.

The interval separating the upper and middle zones has markedly increased clay content as indicated in the lithologic log and corroborated by an increase in gamma emission. The borehole diameter varies significantly in this interval, possibly caused by lateral “walking” of the drill bit in response to an increase in the clay content of the sediments. Resistivity values decrease in this interval, with separations between long and short normal traces indicating a greater influence of less resistant drilling mud in the short normal trace in response to increased borehole diameter.

The interval separating the middle and lower zones also has an apparent increase in clay content. This intervening layer is identified by an increase in the gamma emission and notable slowing in the sonic velocity. Resistivity values drop sharply across this interval as well; however, a significant variance in the borehole diameter as shown by the caliper log is likely influencing these data.

Between 820 and 880 feet bls, a significant drop in overall clay content relative to the middle zone is indicated by a drop in gamma emission and an increase in sonic velocity. The core samples recovered within this interval were found to have a grain-supported matrix with lesser clay in the interstices and low overall consolidation, consistent with the characteristics indicated by the geophysical logs.

A small spike in the gamma emission at approximately 888 feet bls roughly coincides with an increase in overall resistivity and follows an abrupt increase in the borehole diameter between 882 and 888 feet bls. The core recovered from the deepest interval (887 to 897 feet bls) includes the small cobbles and pebbles not seen in shallower cores. These observations are not reflected in the lithologic log possibly because of the subtlety of the change and vertical mixing within the borehole. The abrupt changes noted, coupled with the recovery of the cobbles and pebbles in the deepest core, suggest that the borehole encountered a formation or facies change at approximately 880 feet bls, with the gamma spike at 888 feet bls marking a possible unconformity.

Conclusions

Future analysis of the collected lithologic samples and geophysical data will be carried out to correlate the strata encountered in the boring of MW-4 with the regional geology. Preliminary estimates of the identity of the various formations encountered suggest that most of the borehole intercepts older alluvium and formations of the Palm Spring Group as described by Cassilliano (2002). The recovery of pebbles, cobbles, and rounded fossiliferous-claystone between 887 and 897 feet bls, and the possible existence of an unconformity at 888 feet bls indicated by the gamma emission spike suggest the occurrence of a formation or facies change, possibly coinciding with the basal part of the Palm Spring Group.

References

Cassiliano, M. L., 2002. Revision of the Stratigraphic Nomenclature of the Plio-Pleistocene Palm Spring Group (New Rank), Anza-Borrego Desert, Southern California. Proceedings of the San Diego Society of Natural History, 38, pp. 1-30.

Ellis, D. and Ross, T. M., 2007. An Interpretation of Geologic Materials Encountered in the Boring of Borrego Water District Monitoring Well MW-5. California Department of Water Resources, Southern District Technical Information Record SD-07-2.

Moyle, W.R. Jr., 1982. Water Resources of Borrego Valley and Vicinity, California. U.S. Geological Survey Open-File Report 82-855.

Parkhurst, D.L. and Appelo, C.A.J., 1999. Users Guide to PHREEQC (version 2): A Computer Program for Speciation, Batch-Reaction, One-Dimensional Transport, and Inverse Geochemical Calculations. U.S. Geological Survey Water-Resources Investigations Report 99-4259.

Ross, T. M., 2005. An Interpretation of Geologic Materials Encountered in the Boring of Borrego Water District Monitoring Well MW-3. California Department of Water Resources, Southern District Technical Information Record SD-05-1.

Appendix 1

Borehole geophysical survey results

PACIFIC SURVEYS

ELECTRIC LOG
GAMMA-RAY

Job No. 12684	Company	SO CAL PUMP & WELL
	Well	BORREGO MW4
File No.	Field	BORREGO SPRINGS
	County	SAN DIEGO State CA

Location:

Borrego Airport
East end of runway, south side

Sec. 10S   Twp. 6E   Rge. 35

Other Services:
LL3/GR
SONIC/VDL
BHTV
CALIPER

Permanent Datum	G.L		Elevation 518'	Elevation
Log Measured From	G.L	0'	above perm. datum	K.B.
Drilling Measured From	G.L			D.F.
				G.L.

Date	07-27-06		
Run Number	ONE		
Depth Driller	927'		
Depth Logger	930'		
Bottom Logged Interval	930'		
Top Log Interval	0'		
Casing Driller	16" @ 24'		
Casing Logger	NOT REACHED		
Bit Size	7 7/8"		
Type Fluid in Hole	BENTONITE		
Density / Viscosity	NA		
pH / Fluid Loss	NA		
Source of Sample	PIT		
Rm @ Meas. Temp	16.2 @ 77F		
Rmf @ Meas. Temp	15.2 @ 77F		
Rmc @ Meas. Temp	NA		
Source of Rmf / Rmc	MEAS		
Rm @ BHT	NA		
Time Circulation Stopped	0 HRS		
Time Logger on Bottom	06:45		
Max. Recorded Temperature	NA		
Equipment Number	PS-3		
Location	L.A.		
Recorded By	TRAD/RIDDER		
Witnessed By	Doug Ellis		

<<< Fold Here >>>

All interpretations are opinions based on inferences from electrical or other measurements and we cannot and do not guarantee the accuracy or correctness of any interpretation, and we shall not, except in the case of gross or willful negligence on our part, be liable or responsible for any loss, costs, damages, or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, agents or employees. These interpretations are also subject to our general terms and conditions set out in our current Price Schedule.

Comments

Calibration Report

Database File: 12684.db
Dataset Pathname: SOCAL/MW4/run1/ELOG
Dataset Creation: Thu Jul 27 06:53:30 2006 by Log Open-Cased 060407

ELOG Calibration Report

Serial:	D4
Model:	DTQ
Shop Calibration Performed:	Fri Jan 13 10:44:57 2006
Before Survey Verification Performed:	Fri Jan 13 10:44:59 2006
After Survey Verification Performed:	Fri Jan 13 10:45:04 2006

Shop Calibration

	Readings			References			Results	
	Zero	Cal		Zero	Cal		Gain	Offset
Short	8.639	100.407		10.200	102.200	Ohm-m	1.003	1.539
Long	5.418	94.588		10.200	102.200	Ohm-m	1.032	-17.315
IEE	7094.720	7147.780	counts	7.764	7.823	A		
VSN	8069.680	8131.900	counts	153.919	155.106	V		
VLN	2049.980	2059.220	counts	39.101	39.277	V		

Before Survey Verification

	Readings			References			Results	
	Zero	Cal		Zero	Cal		Gain	Offset
Short	101.284	101.286		101.238	101.262	Ohm-m	10.606	-972.995
Long	102.574	102.569		102.569	102.569	Ohm-m	68.614	-6935.150
IEE	7177.640	7188.640	counts	7.855	7.867	A		
VSN	8167.660	8180.360	counts	155.788	156.030	V		
VLN	2067.920	2071.000	counts	39.443	39.502	V		

After Survey Verification

	Readings			References			Results	
	Zero	Cal		Zero	Cal		Gain	Offset
Short	101.291	101.291		101.284	101.286	Ohm-m	5.546	-460.437
Long	102.568	102.559		102.569	102.569	Ohm-m	0.563	44.827
IEE	7216.000	7220.860	counts	7.897	7.903	A		
VSN	8211.900	8217.460	counts	156.632	156.738	V		
VLN	2078.860	2080.080	counts	39.652	39.675	V		

After Survey Verification compared to Before Survey Calibration

	Zero			Cal		
	Before	After		Before	After	
Short	101.238	101.284	Ohm-m	101.262	101.286	Ohm-m
Long	102.872	102.574	Ohm-m	102.569	102.569	Ohm-m

Gamma Ray Calibration Report

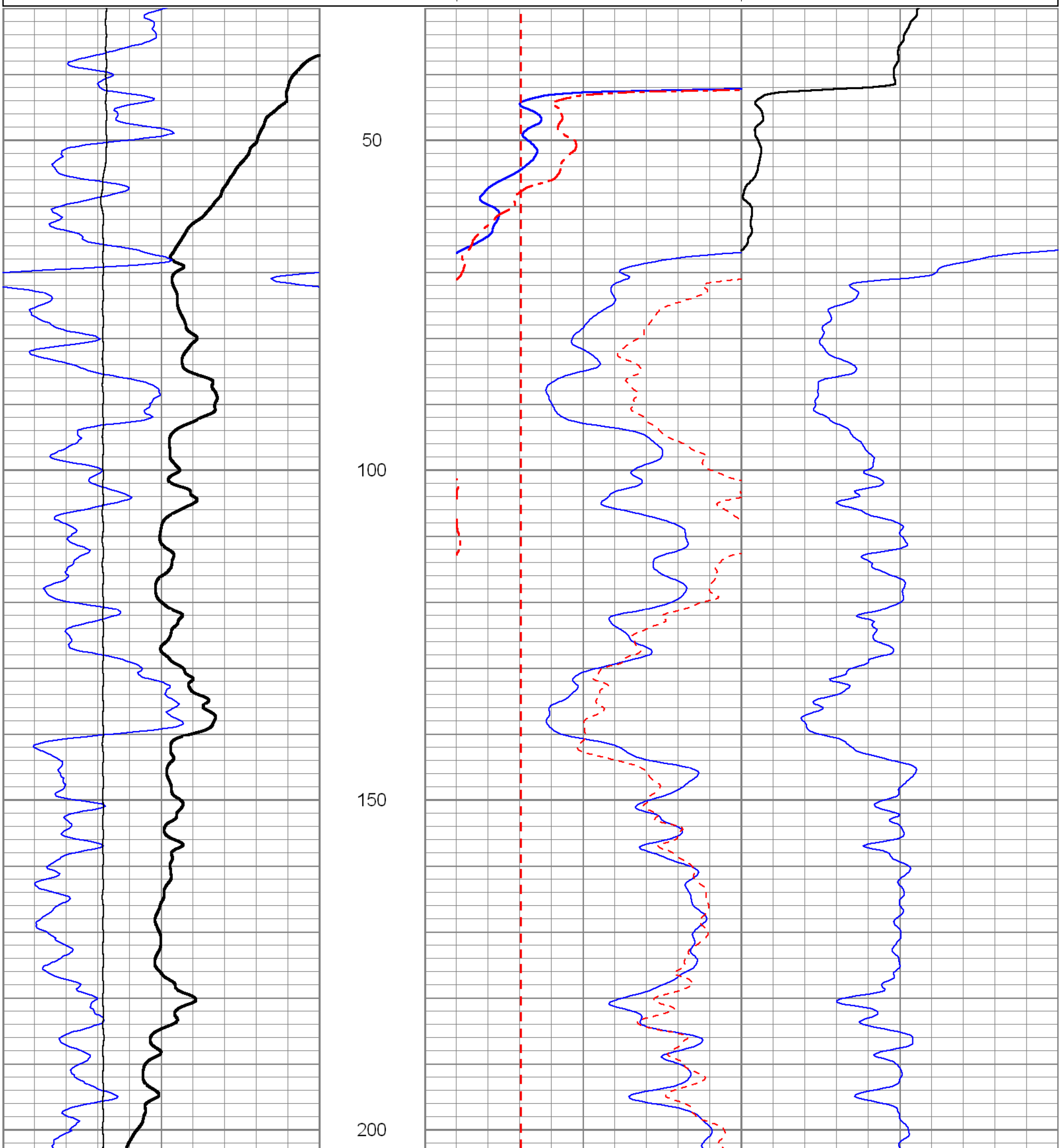
Serial Number:	D4	
Tool Model:	ELOG	
Performed:	Fri Jan 13 10:45:11 2006	
Calibrator Value:	162.0	GAPI
Background Reading:	172.5	cps
Calibrator Reading:	717.9	cps
Sensitivity:	0.2970	GAPI/cps

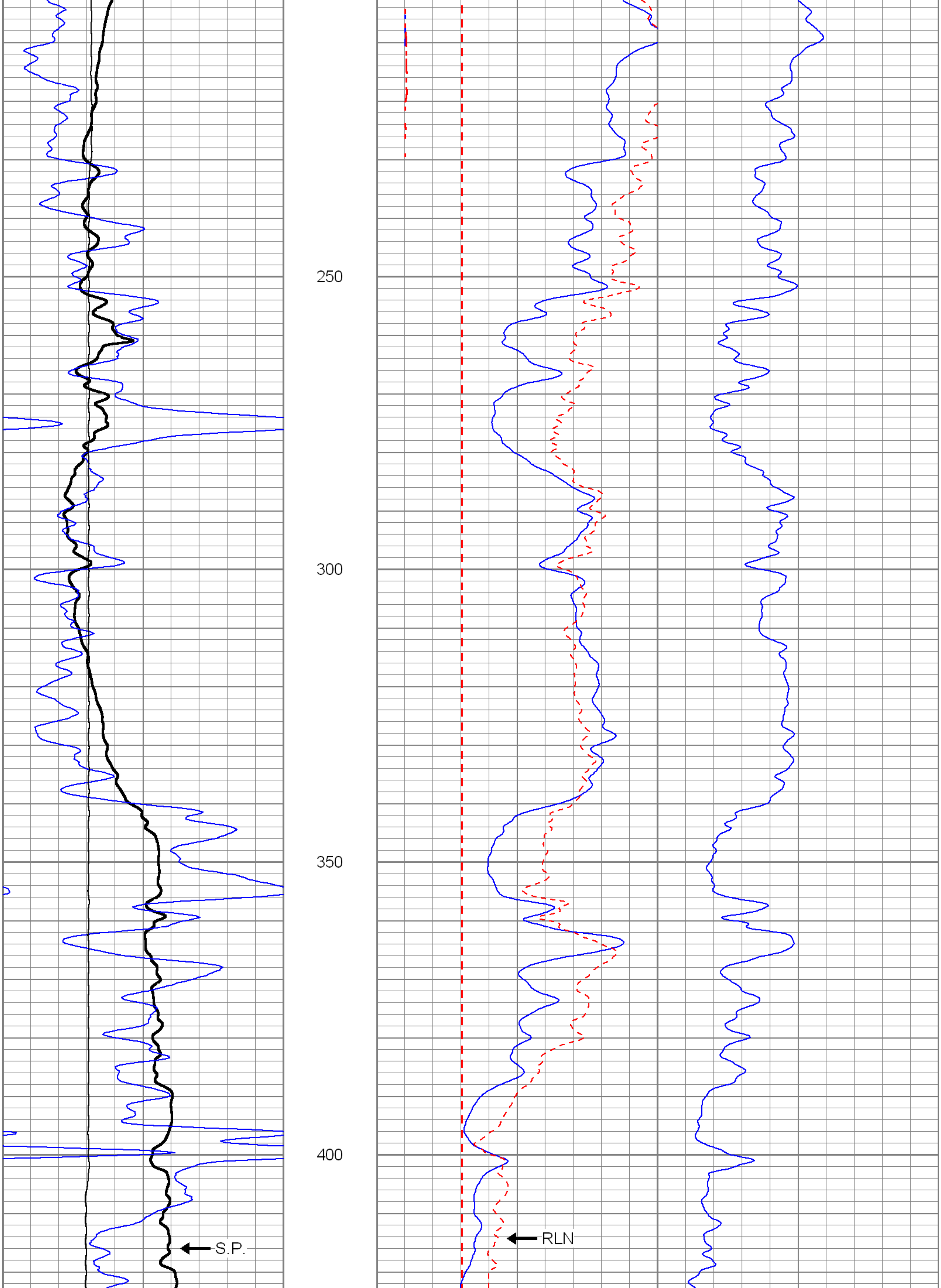
Database File:	12684.db
Dataset Pathname:	SOCAL/MW4/run1/ELOG
Presentation Format:	elog2
Dataset Creation:	Thu Jul 27 06:53:30 2006 by Log Open-Cased 060407
Charted by:	Depth in Feet scaled 1:240

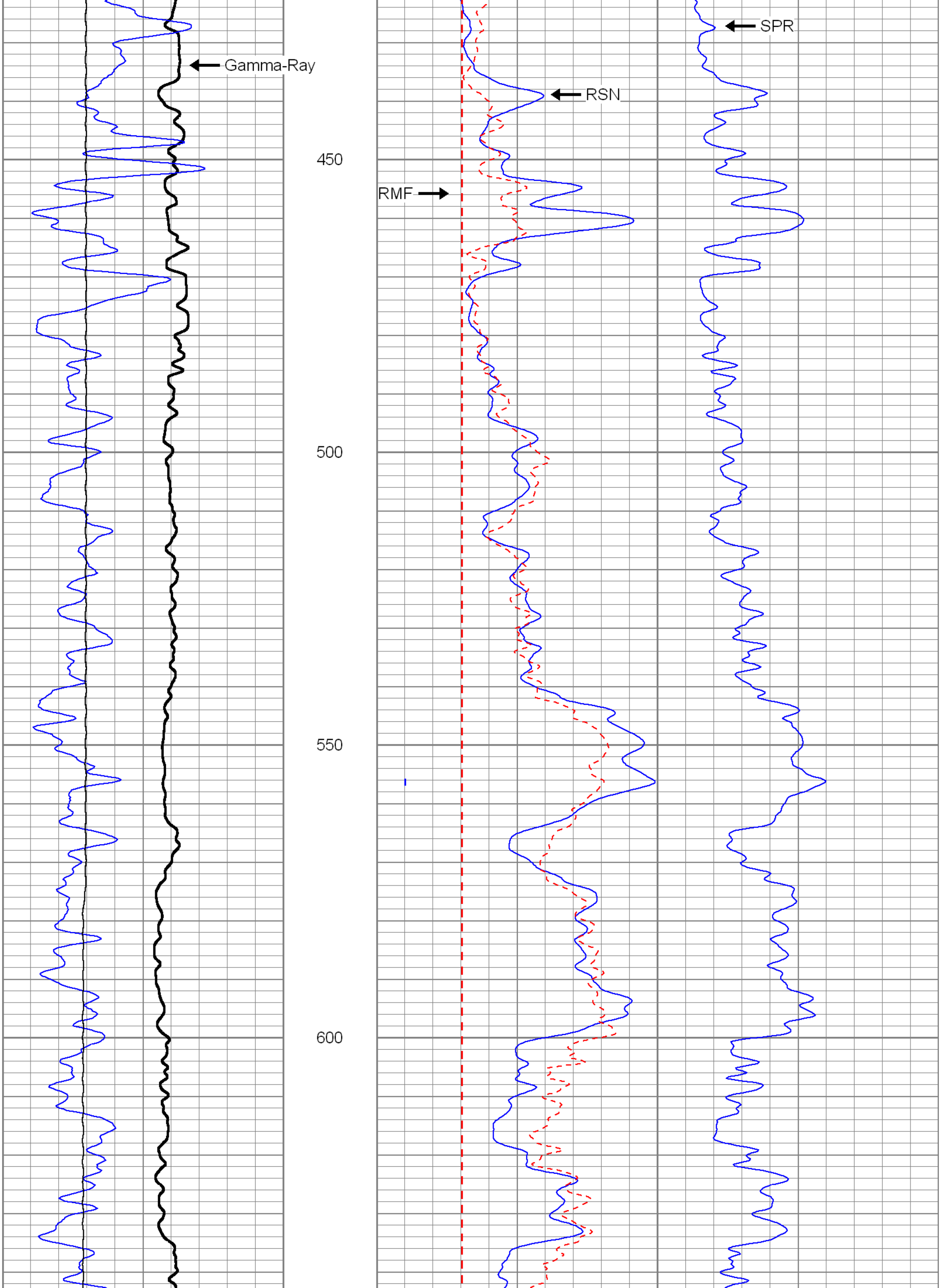
-100	S.P. (mV)	0
40	Gamma-Ray (GAPI)	140
0	Line Speed (ft/min)	-100

0	RSN (Ohm-m)	50
0	RLN (Ohm-m)	50
0	RMF (Ohm-m)	50
50	RSN back-up (Ohm-m)	500
50	RLN back-up (Ohm-m)	500

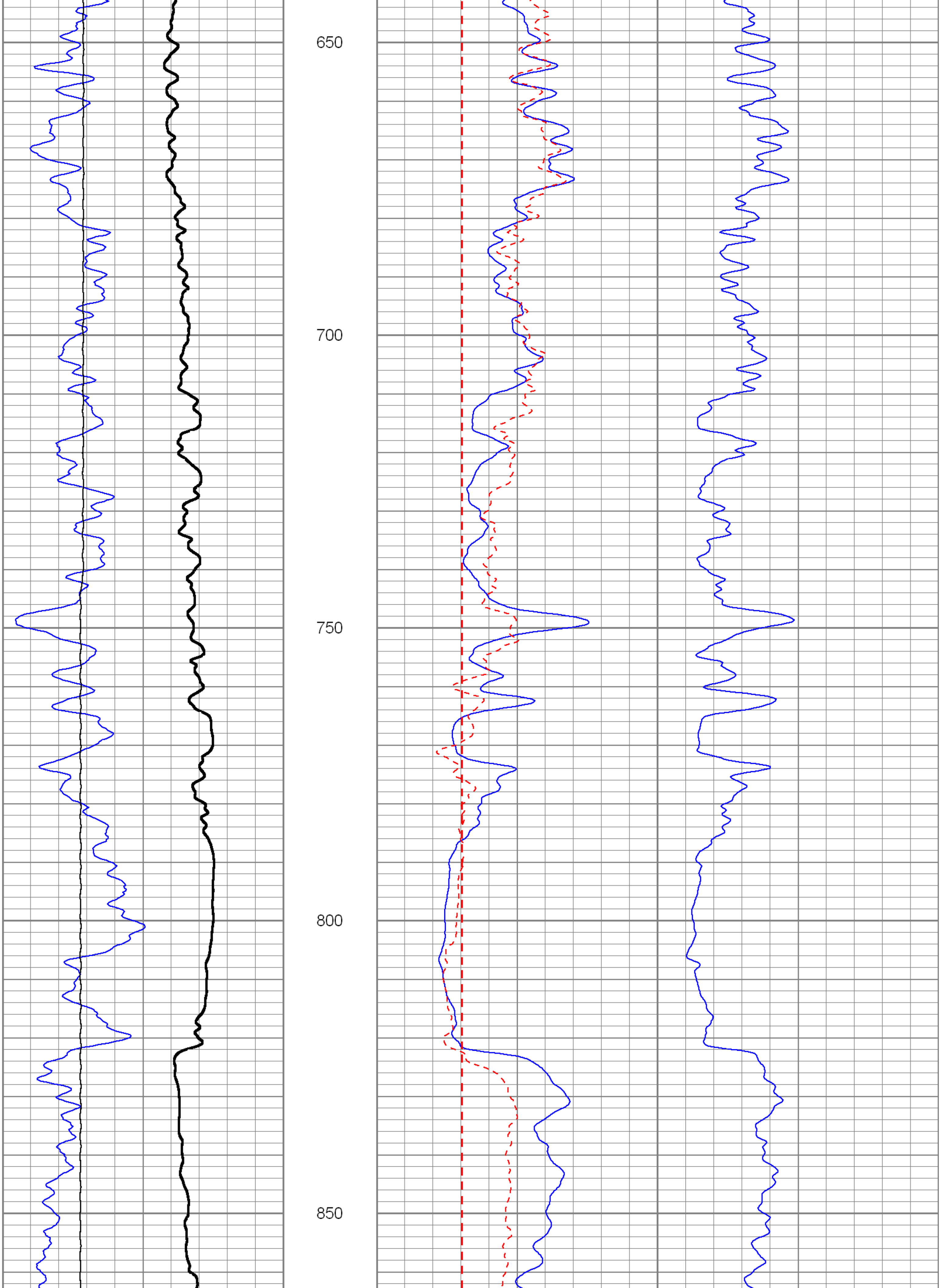
20	SPR (Ohm-m)	100
100	SPR back-up (Ohm-m)	1000

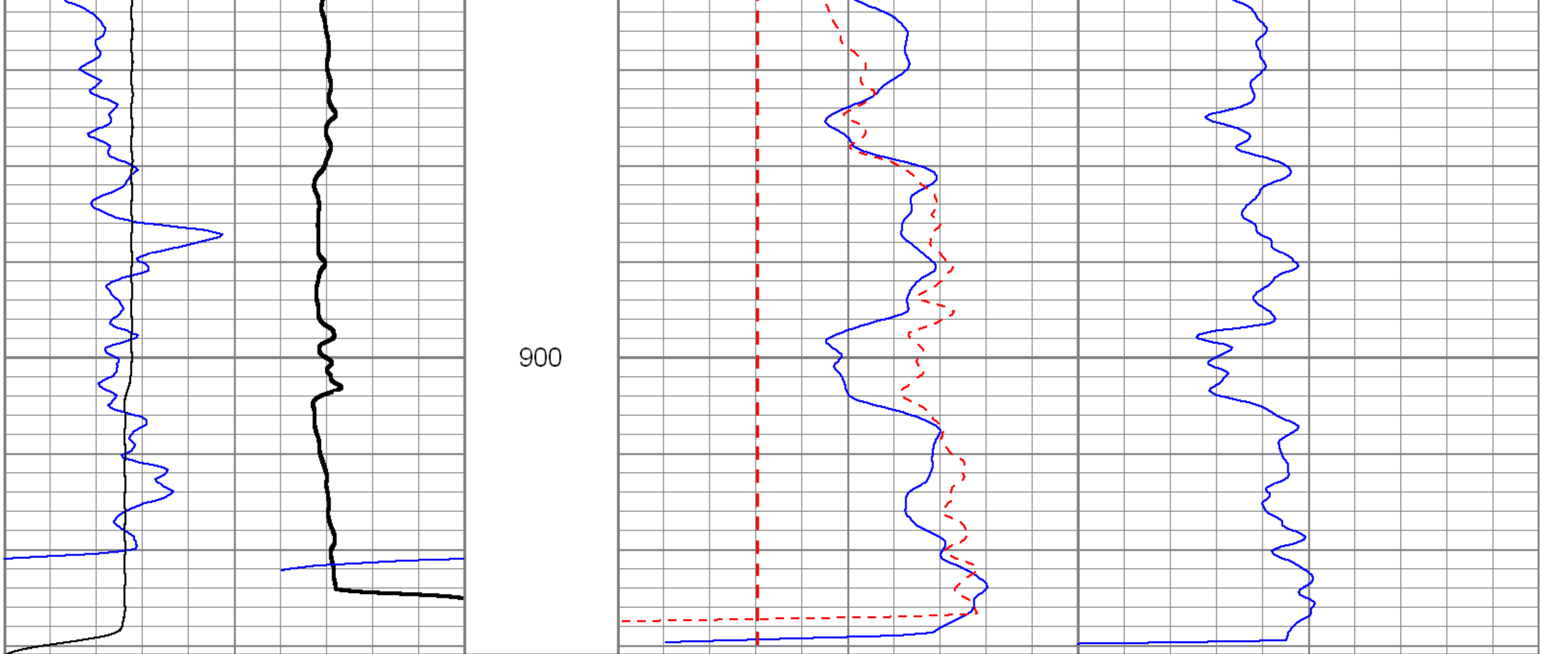



250
300
350
400
S.P.
RLN



Gamma-Ray
RSN
SPR
RMF
450
500
550
600


650
700
750
800
850



-100 S.P. (mV) 0	0 RSN (Ohm-m) 50	20 SPR (Ohm-m) 100
40 Gamma-Ray (GAPI) 140	0 RLN (Ohm-m) 50	100 SPR back-up (Ohm-m) 1000
0 Line Speed (ft/min) -100	0 RMF (Ohm-m) 50	
	50 RSN back-up (Ohm-m) 500	
	50 RLN back-up (Ohm-m) 500	

PACIFIC SURVEYS

SONIC VELOCITY
VARIABLE DENSITY
CALIPER

Job No. 12684

File No.

Company	SO CAL PUMP & WELL
Well	BORREGO MW4
Field	BORREGO SPRINGS
County	SAN DIEGO
State	CA

Location:

Borrego Airport
East end of runway, south side

Sec. 10S Twp. 6E Rge. 35

Other Services:

BHTV
ELOG
LL3/GR

Permanent Datum G.L Elevation 518'
Log Measured From G.L 0' above perm. datum
Drilling Measured From G.L

Elevation
K.B.
D.F.
G.L.

Date	07-27-06		
Run Number	ONE		
Depth Driller	927'		
Depth Logger	930'		
Bottom Logged Interval	930'		
Top Log Interval	0'		
Casing Driller	16" @ 24'		
Casing Logger	NOT REACHED		
Bit Size	7 7/8"		
Type Fluid in Hole	BENTONITE		
Density / Viscosity	NA		
pH / Fluid Loss	NA		
Source of Sample	PIT		
Rm @ Meas. Temp	16.2 @ 77F		
Rmf @ Meas. Temp	15.2 @ 77F		
Rmc @ Meas. Temp	NA		
Source of Rmf / Rmc	MEAS		
Rm @ BHT	NA		
Time Circulation Stopped	0 HRS		
Time Logger on Bottom	06:45		
Max. Recorded Temperature	NA		
Equipment Number	PS-3		
Location	L.A.		
Recorded By	TRAD/RIDDER		
Witnessed By	Doug Ellis		

<<< Fold Here >>>

Comments

Calibration Report

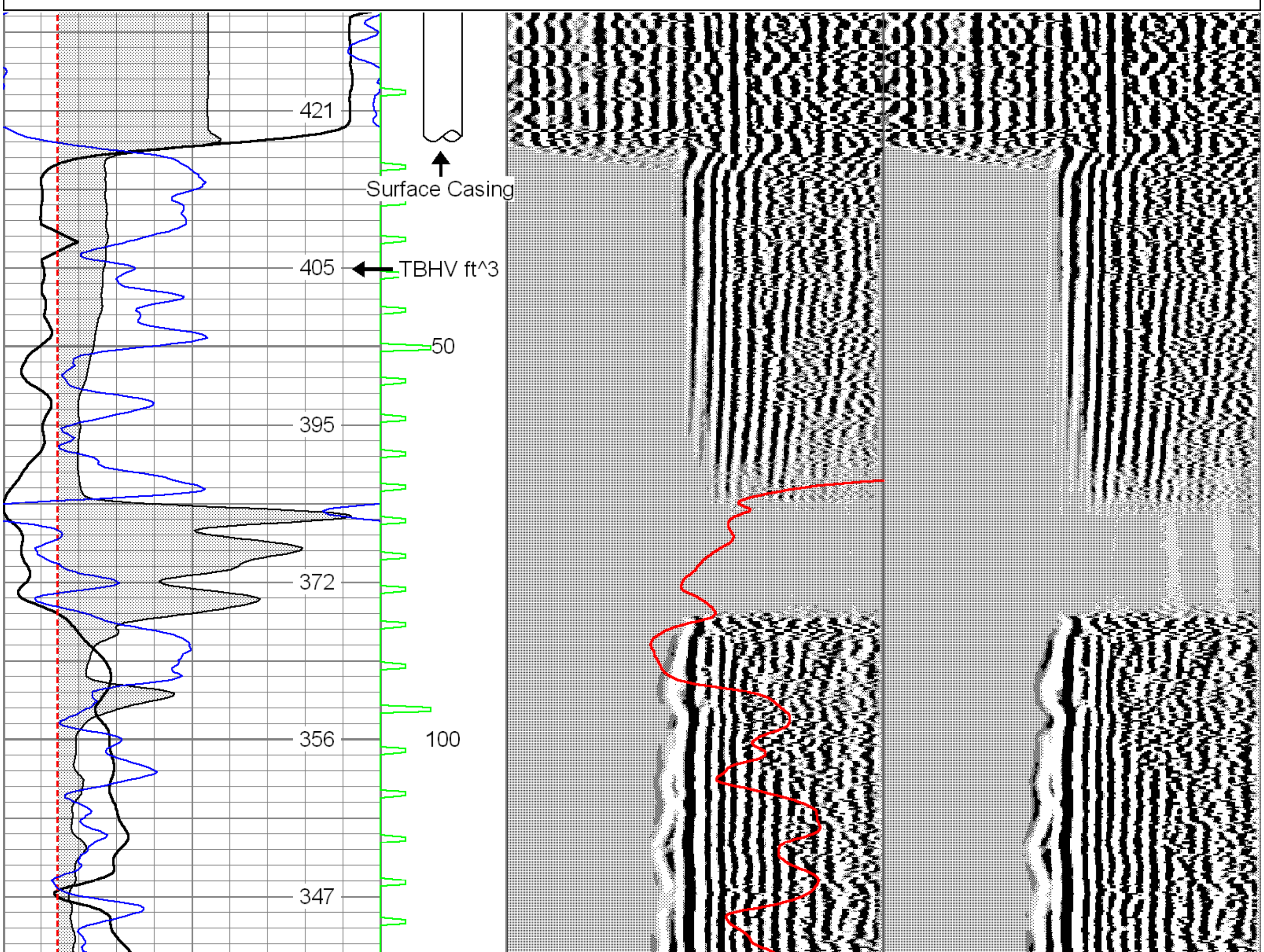
Database File: 12684.db
Dataset Pathname: SOCAL/MW4/run1/CAL
Dataset Creation: Thu Jul 27 09:12:35 2006 by Log Open-Cased 060407

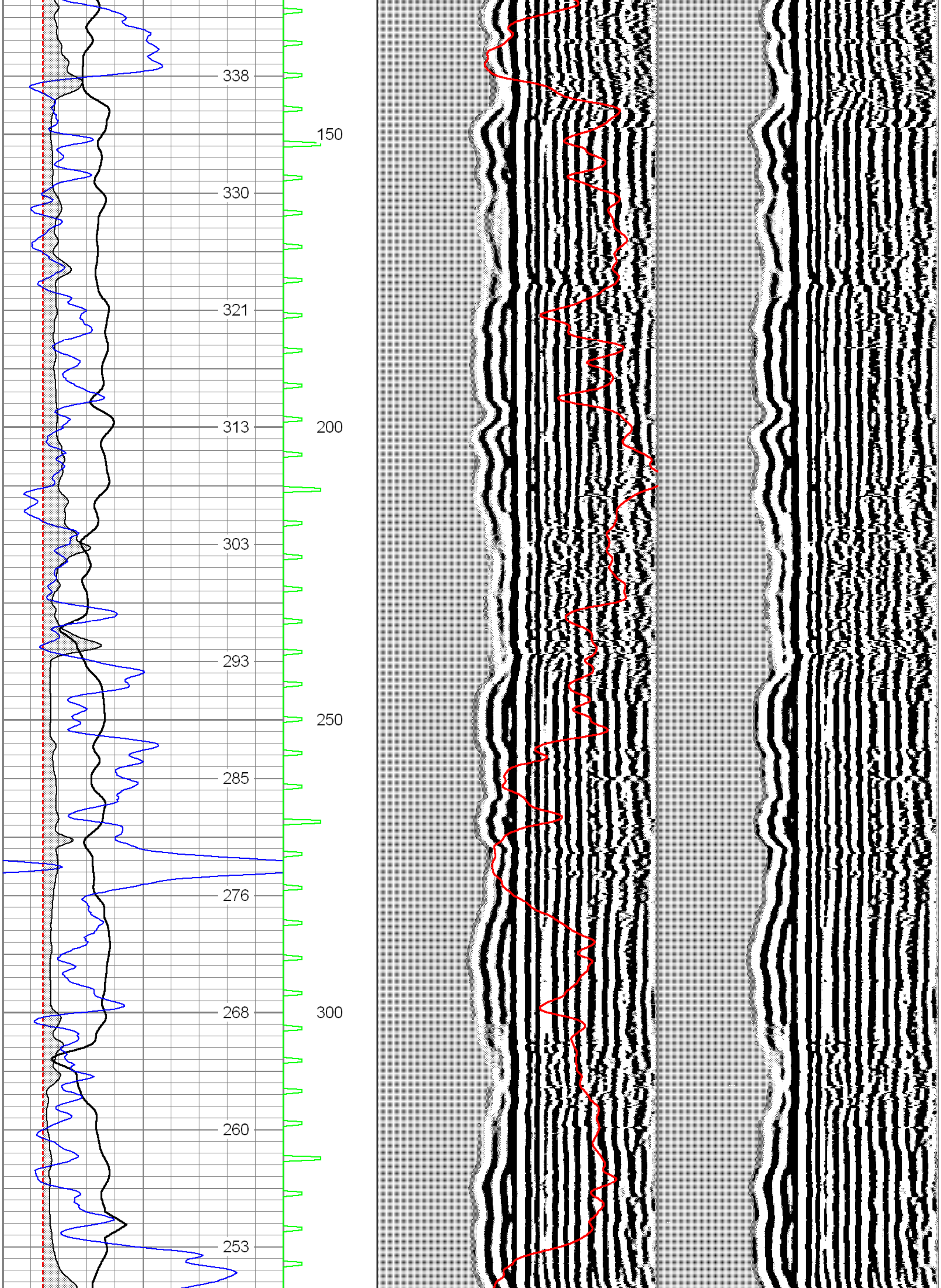
XY Caliper Calibration Report

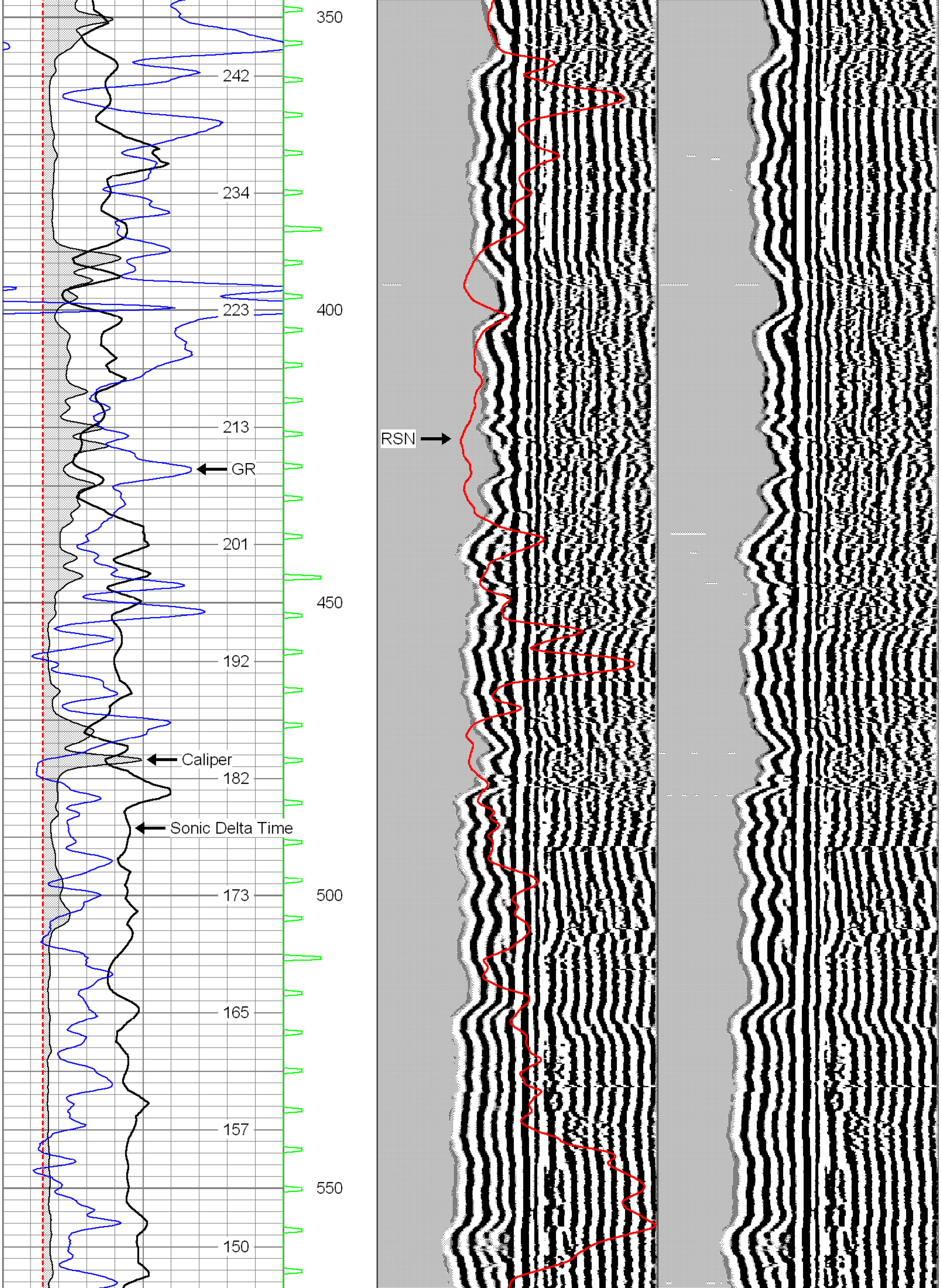
Serial Number:	Short		
Tool Model:	Comprobe		
Performed:	Wed Dec 21 15:18:32 2005		
Small Ring:	6	in	
Large Ring:	18	in	
	X Caliper	Y Caliper	
Reading with Small Ring:	348.657	348.657	cps
Reading with Large Ring:	749.7	749.7	cps
Gain:	0.029922	0.029922	
Offset:	-3.7	-3.7	

Database File:	12684.db
Dataset Pathname:	SOCAL/MW4/run1/SONIC
Presentation Format:	sonic_ca
Dataset Creation:	Thu Jul 27 08:23:29 2006 by Log Open-Cased 060407
Charted by:	Depth in Feet scaled 1:240

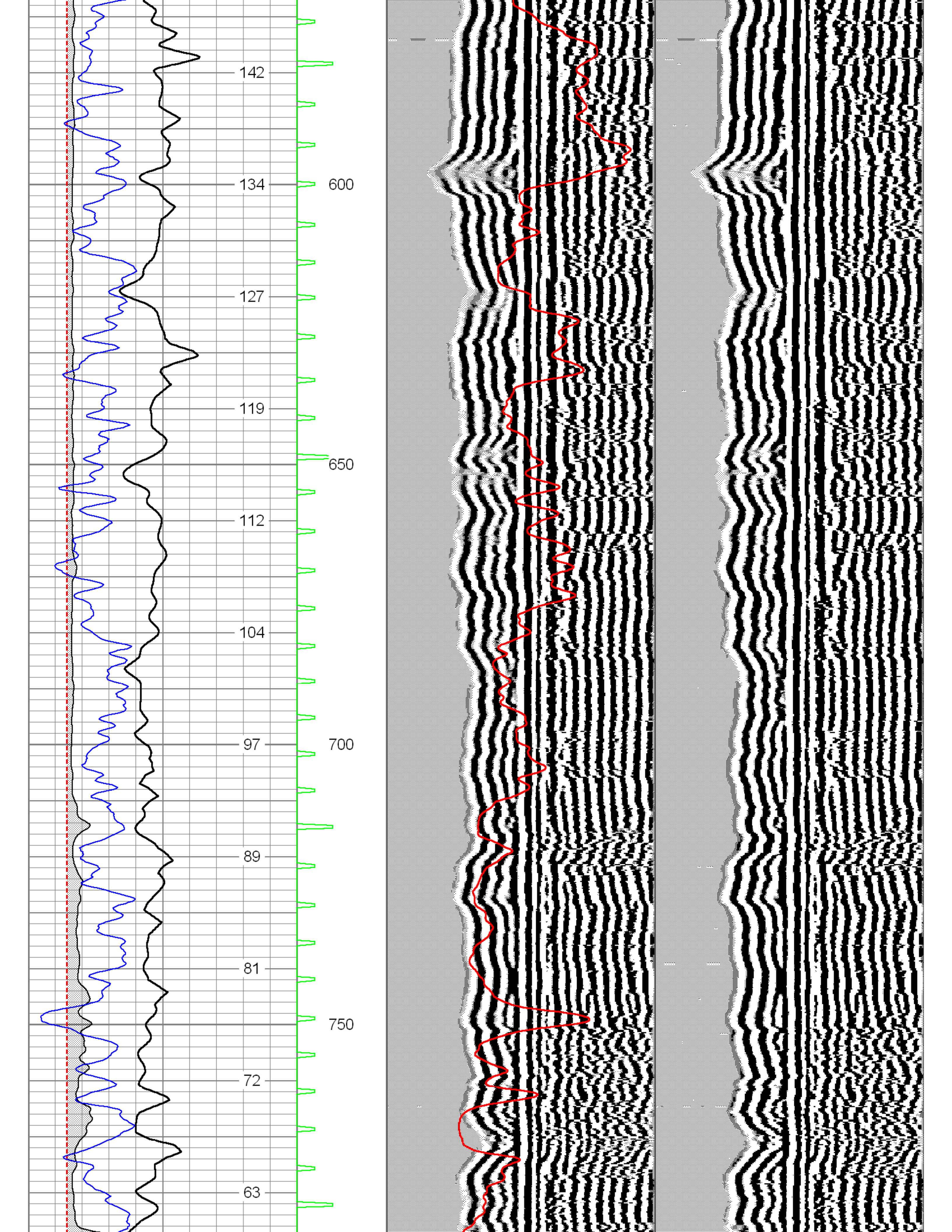
Track 1	Track 2	Track 3	Track 4
240 DT (usec/ft) 40	ITT 0 (msec) 5	500 Variable Density 5 ft 1600	500 Variable Density 5ft 1600
5 CALIPER (in) 25		0 RSN (Ohm-m) 50	
5 Bit Size (in) 25			
40 Gamma-Ray (GAPI) 140			

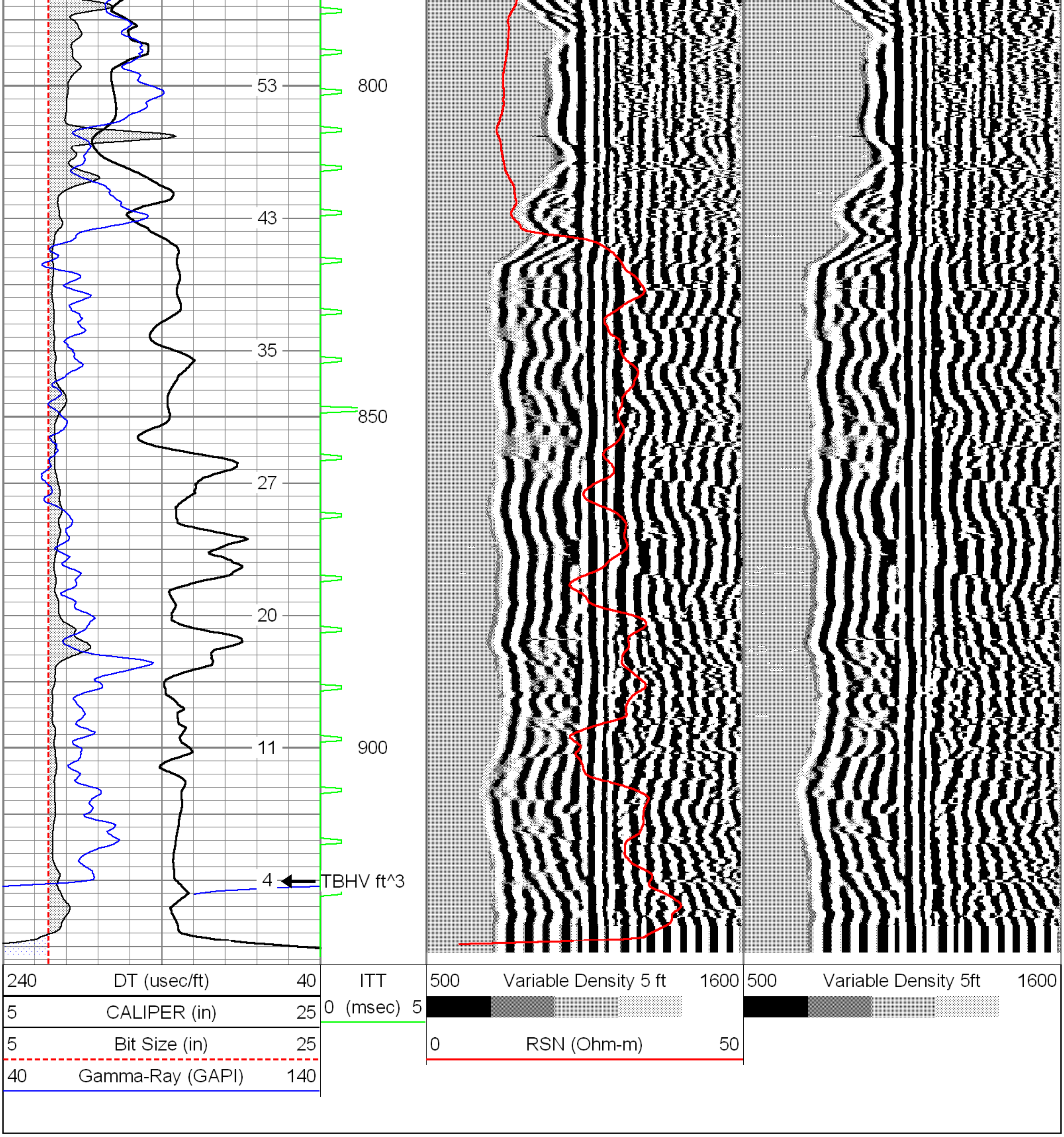



338
150
330
321
313
200
303
293
250
285
276
268
300
260
253



350
242
234
400
223
213
GR
201
450
192
Caliper
182
Sonic Delta Time
173
500
165
157
550
150
RSN


142
134
600
127
119
650
112
104
97
700
89
81
750
72
63


53
43
35
27
20
11
4
800
850
900
TBHV ft^3
240 DT (usec/ft) 40
5 CALIPER (in) 25
5 Bit Size (in) 25
40 Gamma-Ray (GAPI) 140
ITT
0 (msec) 5
500 Variable Density 5 ft 1600
0 RSN (Ohm-m) 50
500 Variable Density 5ft 1600

PACIFIC SURVEYS

LATEROLOG 3
GAMMA-RAY

Job No. 12684	Company	SO CAL PUMP & WELL
	Well	BORREGO MW4
File No.	Field	BORREGO SPRINGS
	County	SAN DIEGO State CA

Location:

Borrego Airport
East end of runway, south side

Sec. 10S   Twp. 6E   Rge. 35

Other Services:
SONIC/VDL
BHTV
CALIPER
ELOG/GR

Permanent Datum	G.L		Elevation 518'	Elevation
Log Measured From	G.L	0'	above perm. datum	K.B.
Drilling Measured From	G.L			D.F.
				G.L.

Date	07-27-06		
Run Number	ONE		
Depth Driller	927'		
Depth Logger	930'		
Bottom Logged Interval	930'		
Top Log Interval	0'		
Casing Driller	16" @ 24'		
Casing Logger	NOT REACHED		
Bit Size	7 7/8"		
Type Fluid in Hole	BENTONITE		
Density / Viscosity	NA		
pH / Fluid Loss	NA		
Source of Sample	PIT		
Rm @ Meas. Temp	16.2 @ 77F		
Rmf @ Meas. Temp	15.2 @ 77F		
Rmc @ Meas. Temp	NA		
Source of Rmf / Rmc	MEAS		
Rm @ BHT	NA		
Time Circulation Stopped	0 HRS		
Time Logger on Bottom	06:45		
Max. Recorded Temperature	NA		
Equipment Number	PS-3		
Location	L.A.		
Recorded By	TRAD/RIDDER		
Witnessed By	Doug Ellis		

<<< Fold Here >>>

Comments

Calibration Report

Database File: 12684.db
Dataset Pathname: SOCAL/MW4/run1/LL3
Dataset Creation: Thu Jul 27 07:41:47 2006 by Log Open-Cased 060407

Gamma Ray Calibration Report

Serial Number:	12
Tool Model:	GROH
Performed:	Thu Feb 12 09:06:37 2004
Calibrator Value:	162.0 GAPI
Background Reading:	46.0
Calibrator Reading:	174.5
Sensitivity:	1.2612 GAPI/

RLL3 (Resistivity Laterolog 3) Calibration Report:

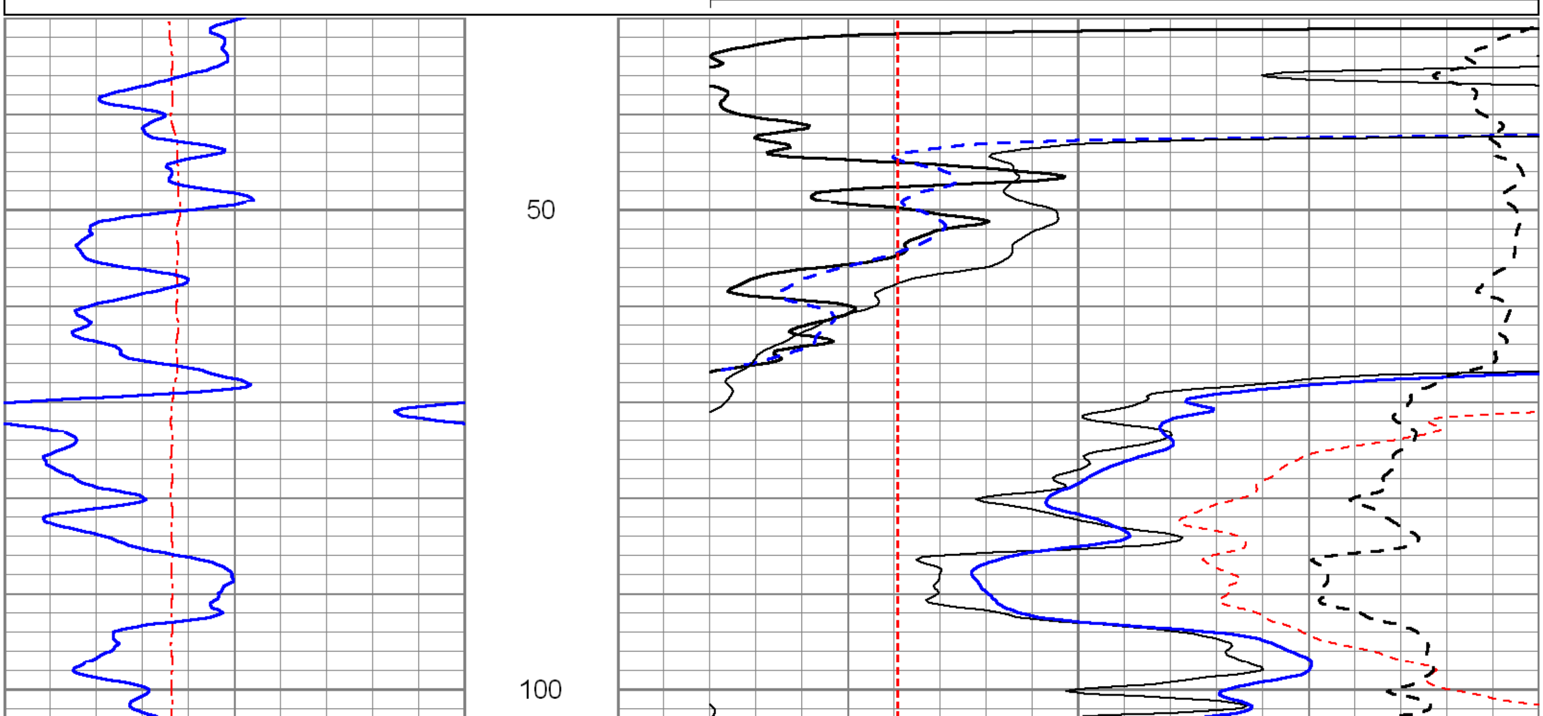
Serial Number:	294
Tool Model:	M&W
Performed:	Mon Jul 25 11:54:08 2005

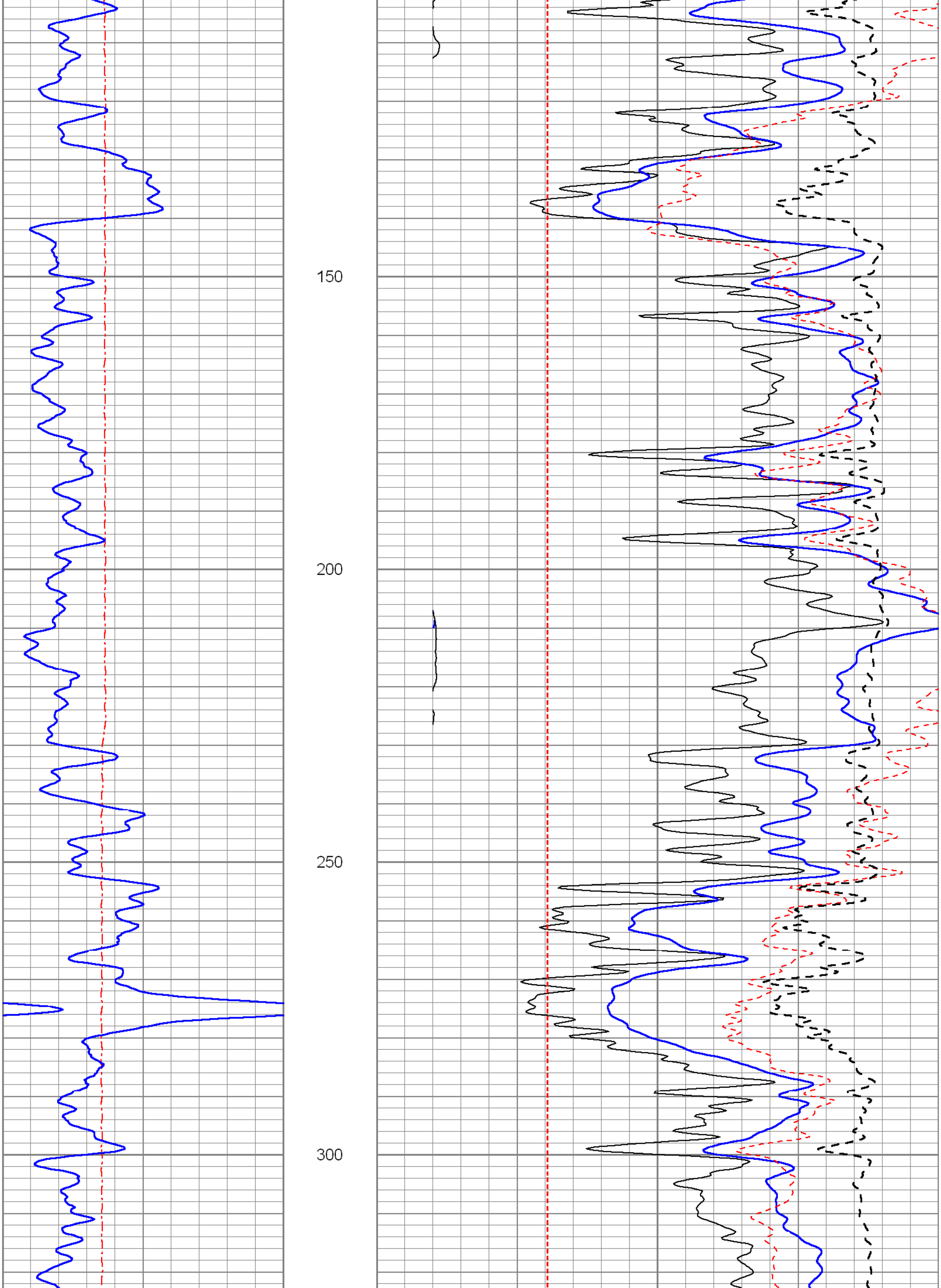
System Reading	Calibration Reference	
0.029	2.500	Ohm-m
0.042	5.000	
0.410	50.000	
2.079	250.000	
4.401	500.000	

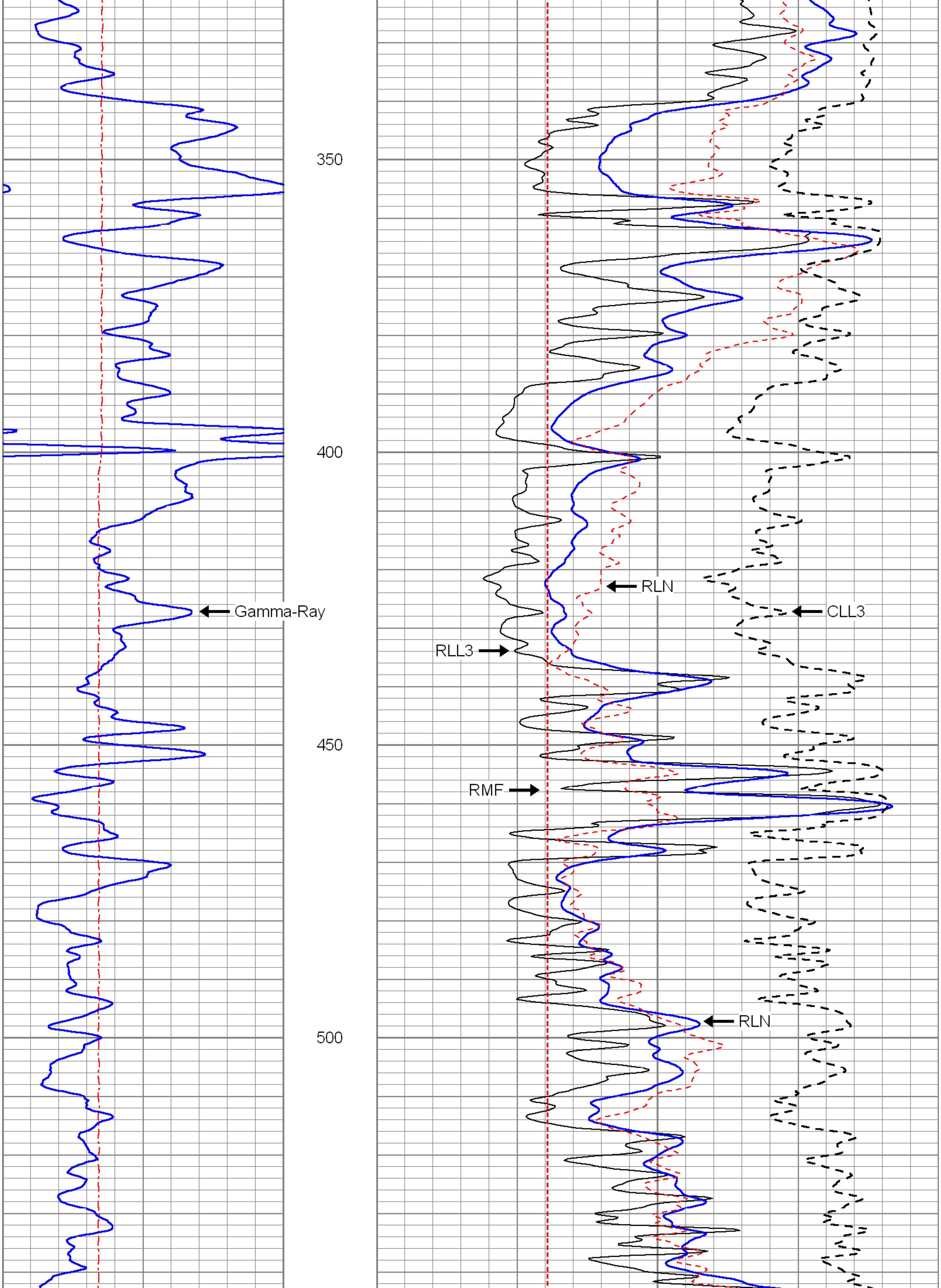
Database File:	12684.db
Dataset Pathname:	SOCAL/MW4/run1/LL3
Presentation Format:	ll3
Dataset Creation:	Thu Jul 27 07:41:47 2006 by Log Open-Cased 060407
Charted by:	Depth in Feet scaled 1:240

0	Line Speed (ft/min)	-100
40	Gamma Ray (GAPI)	140

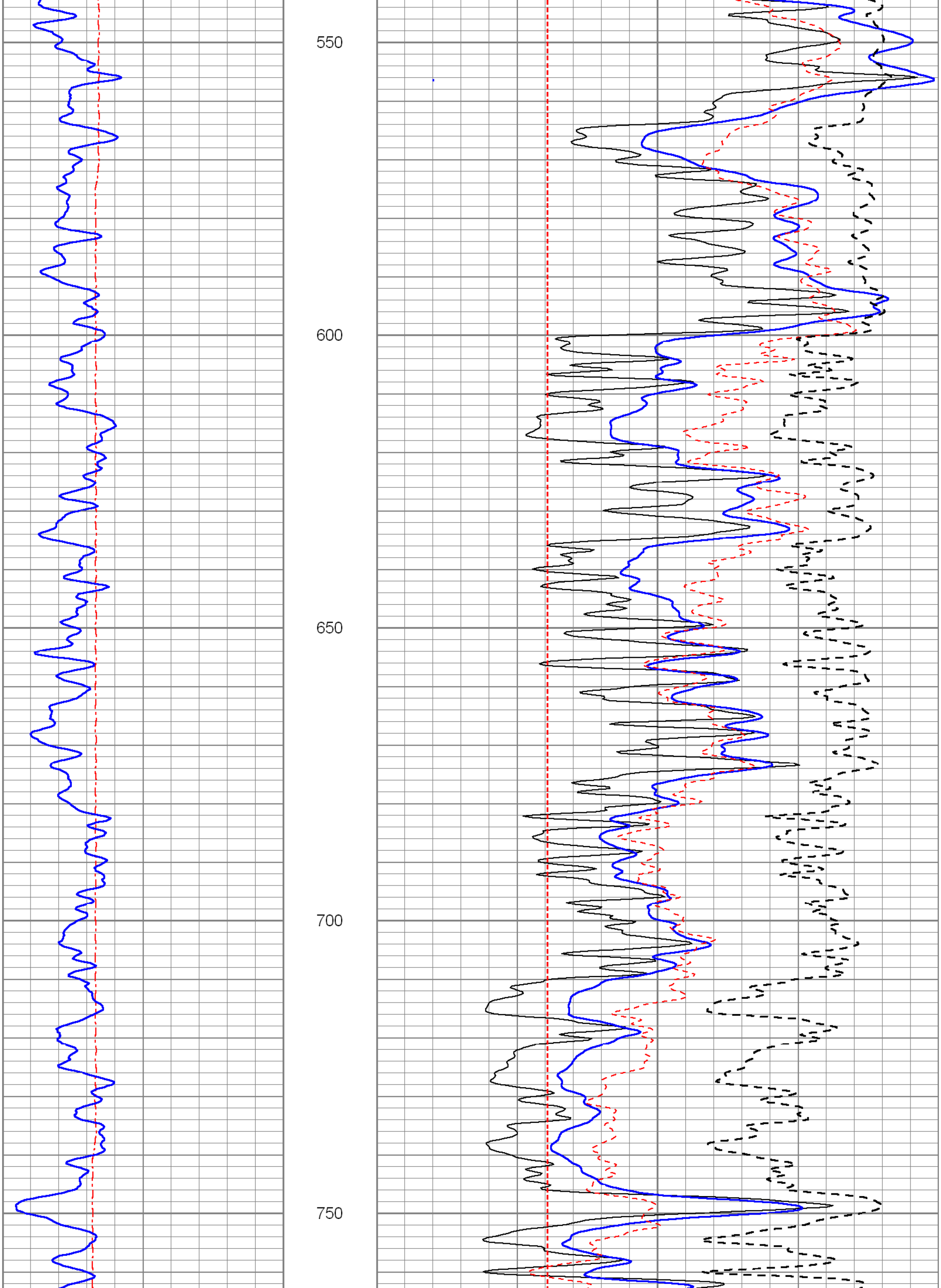
0	*RLL3 (Ohm-m)*	50
0	RSN (Ohm-m)	50
0	RLN (Ohm-m)	50
0	RMF (Ohm-m)	50
250	*CLL3*	0
50	*RLL3 back-up (Ohm-m)*	500
50	RSN back-up (Ohm-m)	500
50	RLN back-up (Ohm-m)	500

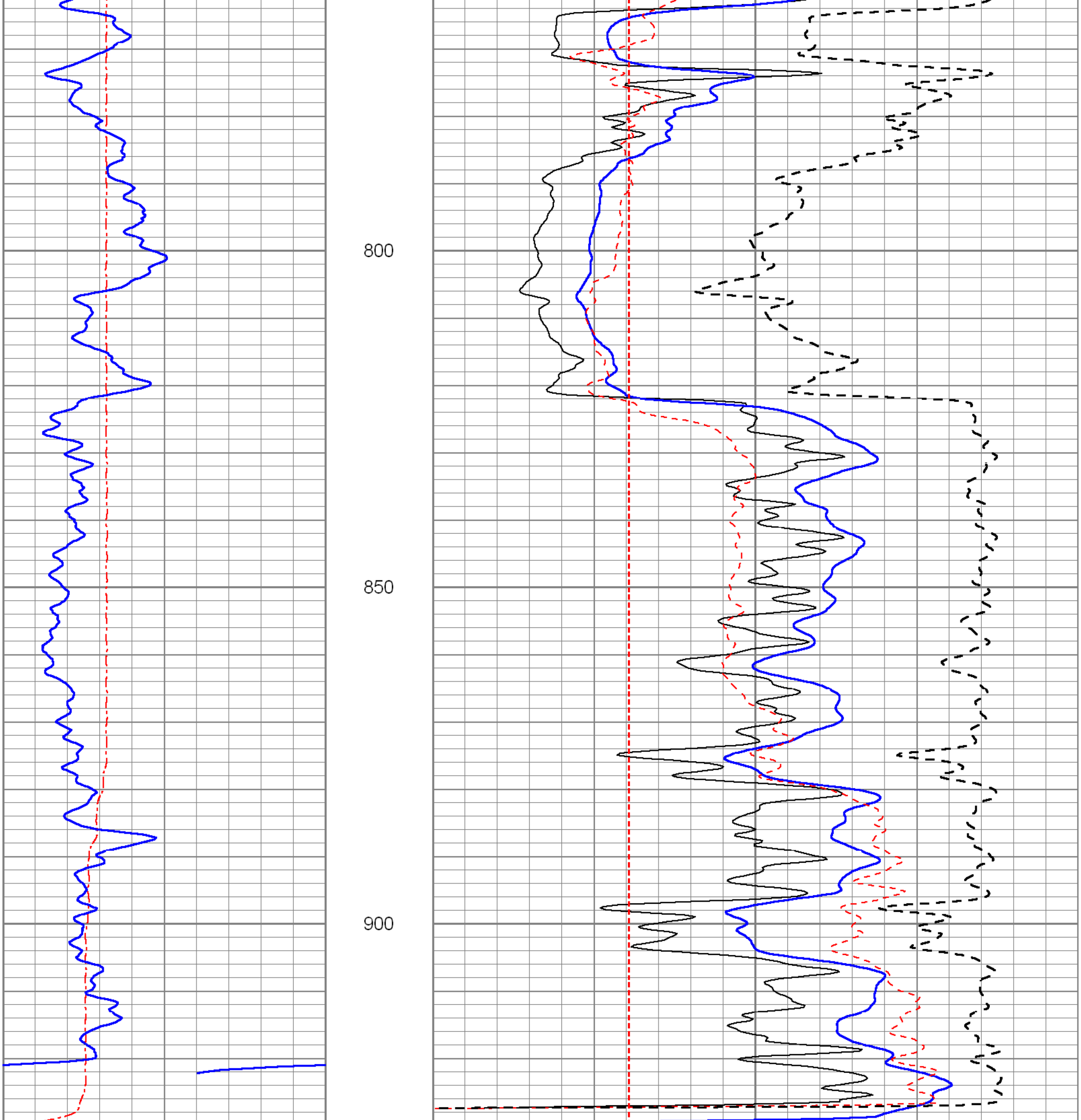



150
200
250
300



350
400
450
500
Gamma-Ray
RLN
CLL3
RLL3
RMF
RLN


550
600
650
700
750



0	Line Speed (ft/min)	-100
40	Gamma Ray (GAPI)	140

0	***RLL3 (Ohm-m)***	50
0	RSN (Ohm-m)	50
0	RLN (Ohm-m)	50
0	RMF (Ohm-m)	50
250	***CLL3***	0
50	***RLL3 back-up (Ohm-m)***	500
50	RSN back-up (Ohm-m)	500
50	RLN back-up (Ohm-m)	500